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MERIDIAN ASTROMETRY IN ROMANIA

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Abstract. Bucharest Meridian Circle, installed in 1924, was used for improving the stellar reference frame. The results were published in the series of Bucharest Catalogues with studies concerning catalogues accuracy and the instrumental errors. The paper mention all the results, among with some important catalogues evaluation.

1. INTRODUCTION

After the founding of the Bucharest Observatory in 1908, the director, Professor Nicolae Coculescu, along with the former Ministry of Education, Spiru Haret, ordered in 1910 a meridian circle at the company Gauthier-Prin. The instrument - having a Steinheil-Merz objective (19 / 235 cm), micrometer with mechanical motion in right ascension, two declination circles (1m diameter, divided every 5′), 6 microscopes, a mercury pool and a level for the determination of the inclination - was installed in the interval 1924-1926 by the astronomer Gheorghe Demetrescu.

The first operation performed with this instrument was the evaluation of the dividing errors of the circles. Professor Demetrescu modified Bruns' method, and carried out this series of measurements with the aid of Constantin Drâmba, Nicolae Dinulescu, Călin Popovici and Gheorghe Petrescu. Obtained in 1932, the results, for mean square and probable square errors were 0".055 and 0".037 for a single diameter, and 0".032 and 0".022 for 6 microscopes measurments (Demetrescu and Drâmba, 1931).

The first astronomical observations were performed for longitudes and time determination, the first step for sistematic observations of stars passages. At that time the Meridian Circle was considered as one of the most performant instruments (Toma, 1992).

2. THE SERIES OF BUCHAREST CATALOGUES

Beginning with 1952, the methods of observation and reduction were tested on the Catalogue of Variable Stars (VS) (Drâmba, 1954) with the main contribution of Academician Gheorghe Demetrescu. The cooperation agreement (1953) between Bucharest Observatory and Pulkovo Main Observatory, by means of the Academies, started the works for building star catalogues in international cooperations. The Catalogue of Fundamental Faint Stars (FKSZ) (Drâmba, 1957) was the first which was

compiled (Zverev and Polojentzev, 1958) and included in the preliminary Catalogue of Fundamental Faint Stars.

The interpretation of the instrumental errors and their effects on the final results create the opportunity to begin new programmes in the field of meridian astrometry. The Catalogue of Faint Stars (KSZ) (Marcus *et al.* 1972) contained a significant number of stellar positions (over 25000) in declination zone $(-11°, +11°)$, positions observed between 1955 and 1963. Under the supervision of Ella Marcus, eminent Romanian astrometrist, an important number of astronomers had observed and processed the catalogue. The main results, published in the catalogue, were the transforming FKSZ positions from the FK3 to FK4 system (Toma and Tudor, 1968), the computation of apparent places, the correction of KSZ positions with the systematic differences FK4-FK3 (Ionescu, 1972), the reduction to the 1950.0 equinox, the final analysis of the results and the computation of equatorial coordinates in the second approximation (Marcus *et al.* 1972). Other studies in this catalogue concern the effects of tube's flexion on stellar positions (Rusu, 1972), the variation of instrument's collimation, azimuth and inclination of rotational axis (Toma, 1972), determination of the instrumental system and statistical studies of the results.

The reference frame obtained was included in the general compilation of KSZ Catalogue, which was used as reference frame for Southern Reference Stars, AGK3R and FK5 Catalogues. There were published studies of comparison of KSZ frame with AGK3R (Marcus, 1979). The working group which elaborated this catalogue (KSZ) obtained in 1972 the Main Award "Gh. Lazăr" of the Romanian Academy.

As a result of the collaboration with the U.S. Naval Observatory, the Catalogue of Southern Reference Stars (SRS) and Bright Stars (BS) (Marcus *et al.* 1979), contained the coordinate frame in the observational zone $(-10°, +5°)$ for SRS and $(-11°, +6°)$ for BS, by means of differential observations in the FK4 system. The aim of this programme was to connect reference frames from Northern and Southern hemispheres. The reduction methods and the evalution of instrumental parameters were more effective and the final results were better, the number of inaccurate positions was minimum. The studies of the accuracy of the catalogue (Tudor and Toma, 1979; Popescu and Creţu, 1979; Niţă and Liculescu, 1979), are relevant for the quality of the work performed.

The results of the study of the system of FK4 reference stars (Popescu *et al.* 1979), shows no systematic in function of right ascension, figure 1.

In function of declination, figure 2 evaluate the systematic $(O-C)_\alpha$ differences in the observation zone $(-15°, +15°)$.

Tecnological development and the necessity of having more accurate positions and proper motions determined a strong research activity for the modernization of meridian circles. Classical micrometers were modified in order to detect stellar images by photometrical methods with important results in detecting faint stars and growing the efficiency of the observational process (Mazurier *et al.* 1977). The new technology allowed to observe 40-50 stars per hour (instead of 10-20 obtained with the classical micrometer) leading to a good accuracy in right ascension. The methods of photography or photoelectric investigation of the declination circle were an important gain in growing declination accuracy. In Bucharest Observatory these topics were not studied.

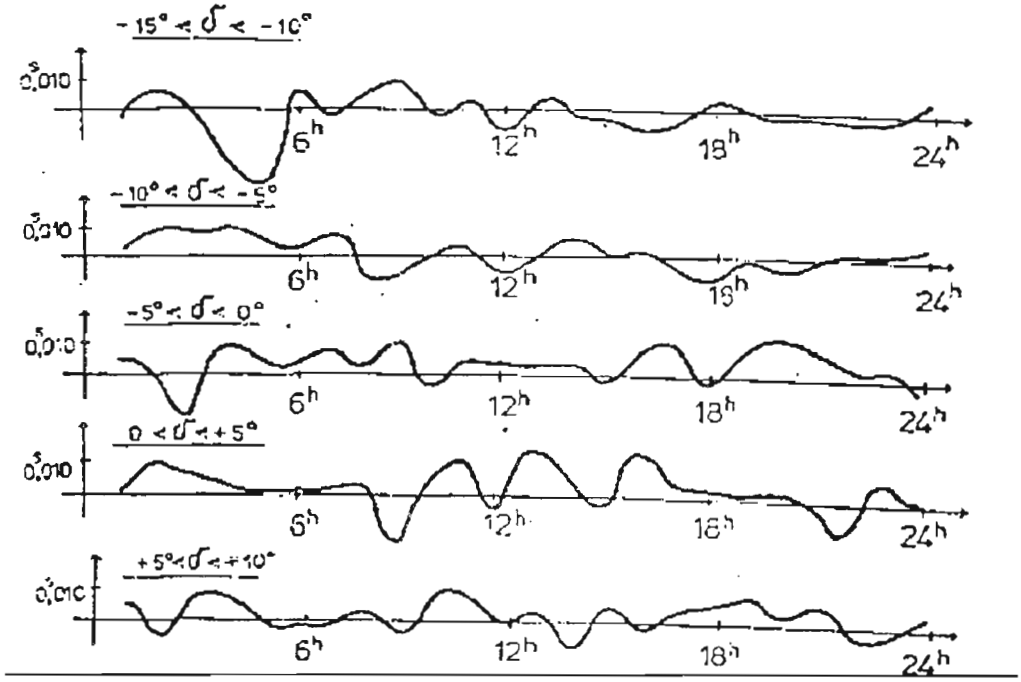

Fig. 1.

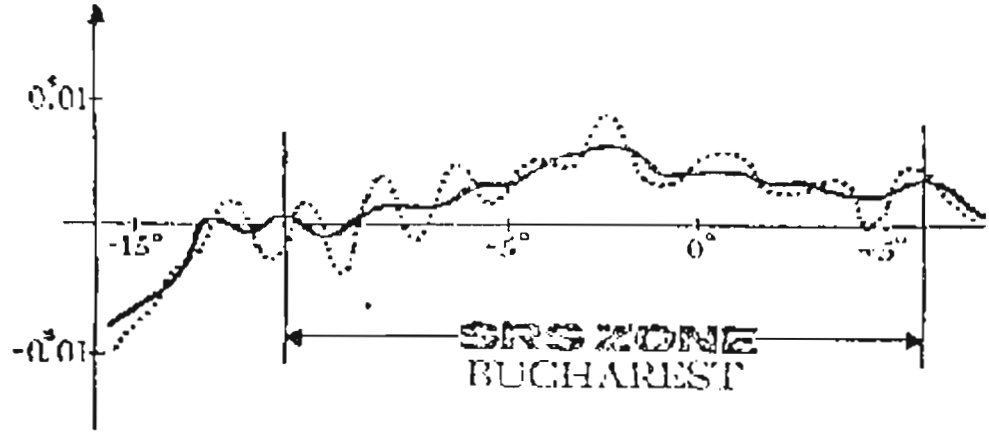

Fig. 2.

The Meridian Astrometry Group tried to observe complementary programmes that cannot be performed with photoelectric methods.

Reconsidering a recommendation of the IAU there were observed Double Stars Catalogue (DS1) declination zone (0°, +21°)and Bright Stars Catalogue (BS2) declination zone (+5°, +25°) (Popescu and Liculescu, 1997). The accuracy of these catalogues were studied (Popescu *et al.* 1991) and compared with other similar catalogues (Popescu and Liculescu, 1994).

The analyse of $\Delta_\alpha \cos\delta$ differences in function of right ascension for double stars and bright stars are showed in figure 3 and figure 4.

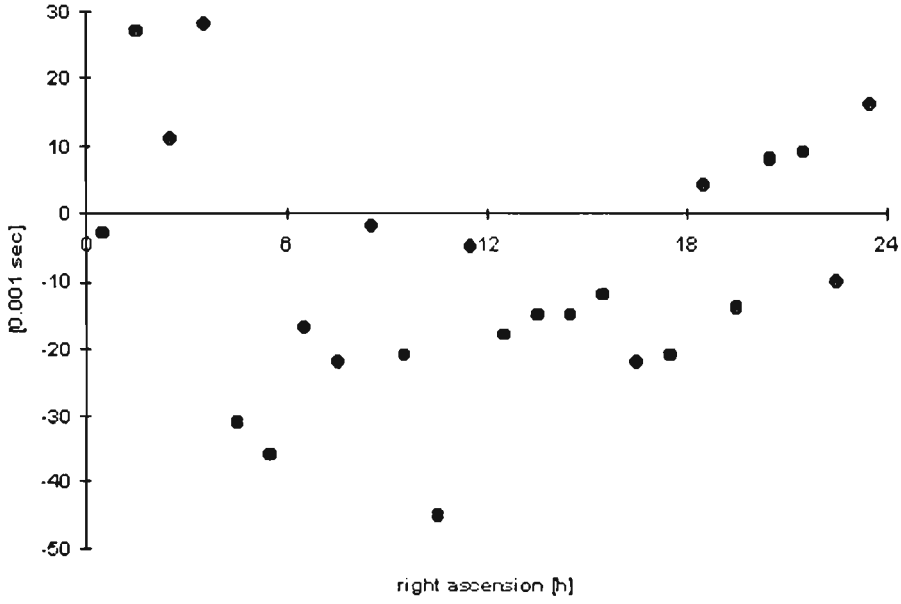

Fig. 3.

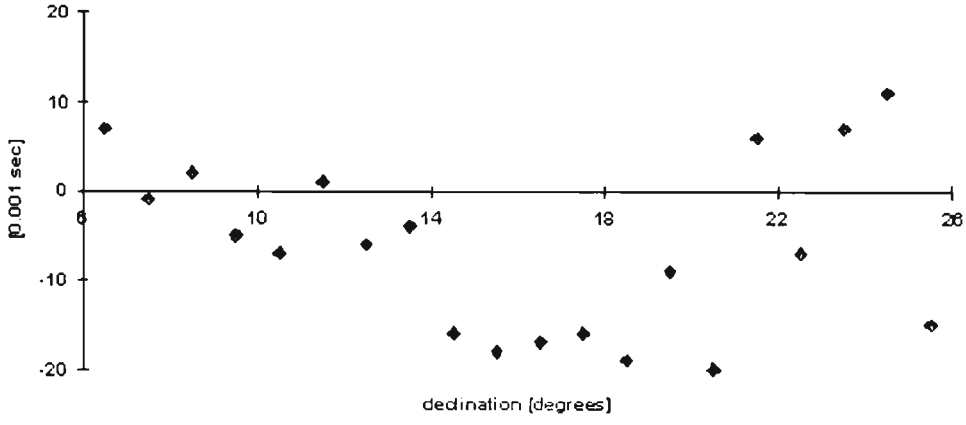

Fig. 4.

The study of the Earth's rotation has promoted new instruments: Danjon Astrolabes and Photographic Zenital Tubes. The Danjon Astrolabe, by means of its qualities (Chollet, 1993), using the equal heights method, was able to perform quasi-absolute determinations of stellar positions. The high accuracy of the results, allowed the determination of stellar positions referred to the vertex and important contributions in improving the reference systems (Chollet, 1995).

On the other hand, Photographic Zenital Tubes, using a different method, needed accurate zonal catalogues as reference frame. This was the reason of observing the NPZT Stellar Catalogue (NPZT), declination zone $(+41°, +63°)$, (Toma and Tudor, 1982) under the coordination of Tokyo Observatory. The programme was observed with Double Stars Catalogue (DS2), declination zone $(+40°, +60°)$. The final results in declination were included in the compilation of NPZT Catalogue; the results in right ascension being included in the second edition of NPZT Catalogue, results wich has been compared with other catalogues (Sadzakov, 1986).

In the idea of building zonal catalogues for the use of Photographic Zenital Tubes there were observed in collaboration with Ondrejov Observatory: PZT Catalogue (P1) (Toma *et al.* 1986) and PZT Catalogue (P2) (Popescu *et al.* 1987) declination zone $(+49°, +50°)$. In collaboration with Cagliari Observatory we elaborate PZT Catalogue (C) declination zone $(+39°)$ (Liculescu *et al.* 1983). All these zonal catalogues were used for comparing the positions observed in Ondrejov and in Cagliari.

The last observed was Double Stars Catalogue (DS3), declination zone $(-5°, +5°)$ (Popescu and Liculescu, 1996).

Table 1 shows the catalogues from the series of Bucharest Catalogues, with the mean square errors for one observation: $\epsilon_\alpha \cos\delta$, units $\pm 0^s.001$; ϵ_δ, units $\pm 0".01$.

3. ACTUAL TOPICS OF RESEARCH

The beginning of Hipparcos mission, its important objectives, produced a different approach of astrometric researches. The accuracy of the positions and proper motions obtained during the Hipparcos programme forced the old instruments to stop the observations. This was the case of Bucharest Meridian Circle. The instruments with higher preformances, modernized with CCD detectors can continue the meridian observations in order to improve the reference frames and Hipparcos system.

In the last years, in Bucharest Observatory we start the modernization of a Danjon Astrolabe borowed form Brussels Royal Observatory, in cooperation with the "Group of Reference Systems and Astrolabe", DANOF, Paris Observatory, group led by Dr. Fernand Chollet. There were made studies and instrumental improuvements of the astrolabe (Popescu *et al.* 1996), in order to analyse stellar images with a CCD camera (Popescu, 1996). The improvement of the optical system of the astrolabe by using a zerodur reflector prism will raise the accuracy of the positions and the efficiency of the observational process (Chollet, 1996).

Table 1.

Bucharest Catalogue of:	declination zone	period of observation	$\epsilon_\alpha \cos\delta$	ϵ_δ	references
Variable Stars (VS)	-10o,+75o	1952-1953	-	-	Dramba, C., 1954
Fundamental Faint Stars (FKSZ)	-30o,+90o	1953-1956	26	52	Dramba, C., 1957
Faint Stars (KSZ)	-11o,+11o	1955-1962	29	49	Marcus, E.,et al 1972
Southern Reference Stars (SRS)	-10o,+5o	1962-1967	18	32	Marcus, E.,et al 1979
Bright Stars (BS1)	-11o,+6o	1962-1967	18	32	Marcus, E.,et al 1979
Double Stars (DS1)	0o,+21o	1966-1971	25	29	Popescu, P., Liculescu, M., 1997
Bright Stars (BS2)	+5o,+25o	1966-1971	22	32	Popescu, P., Liculescu, M., 1997
Northern PZT Stars (NPZT)	+41o,+63o	1971-1975	16	29	Toma, E., Tudor, M., 1982
Double Stars (DS2)	+40o,+60o	1971-1976	-	-	-
PZT Stars (P2)	+49o,+50o	1972-1975	16	26	Popescu, P., et al 1987
PZT Stars (C)	+39o	1977-1979	19	28	Liculescu, M., et al 1983
PZT Stars (P1)	+49o,+50o	1980-1983			Toma, E., et al 1986
Double Stars (DS3)	-5o,+10o	1985-1989	27		Popescu, P., Liculescu, M.,1996

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